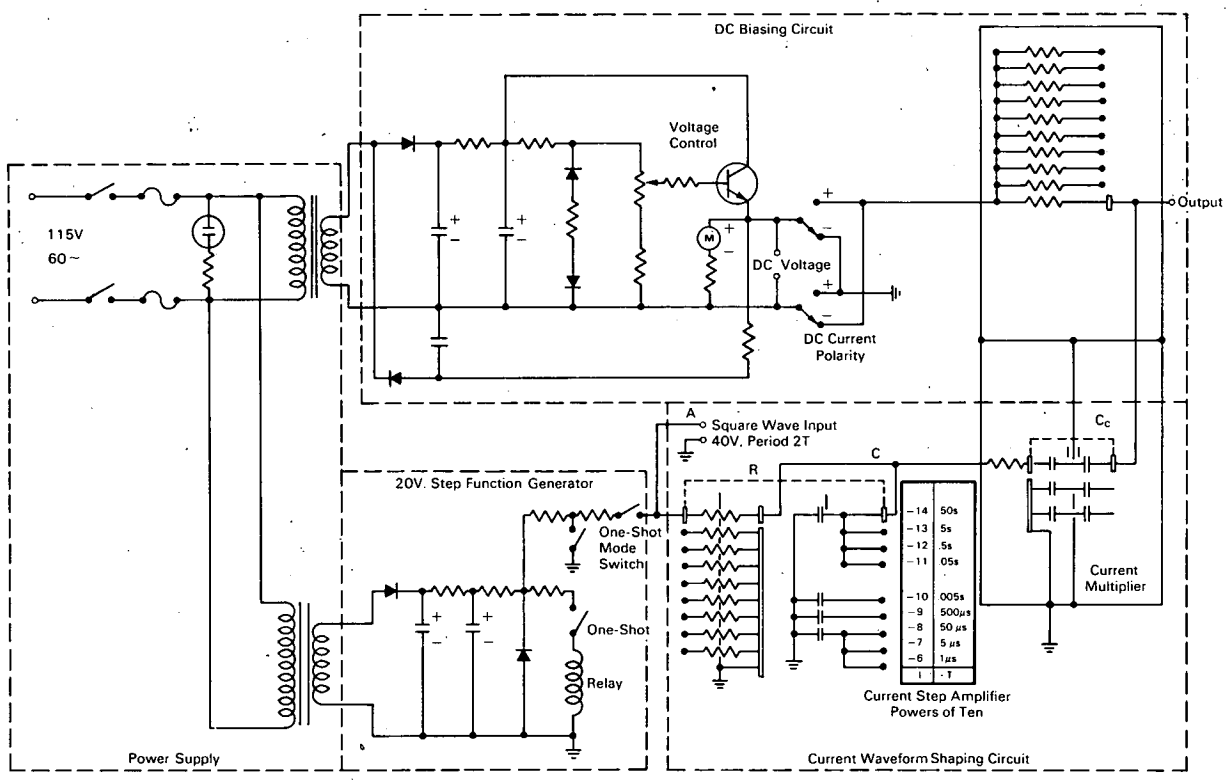
AEC-NASA TECH BRIEF

Electronic Test Instrument Generates Extremely Small Current Signals



The problem:

The develop a source of dynamic test signals in the range from 10^{-4} to 10^{-12} amperes. This source must develop a square output current waveform, rather than a square output voltage waveform, and the waveform must have a short rise time with negligible overshoot or ringing. Rise times range from about 0.1 μsec at 10^{-4} ampere, to 1 μsec at 10^{-9} ampere, and 100 μsec at 10^{-12} ampere. Instruments with such short rise times are not generally available.

The solution:

A signal generator involving an extension of the technique of applying a triangular voltage waveform to a small capacitor to obtain a square-wave output current, or ramp function to obtain a step function output. The effects of stray capacitance are minimized by appropriate shielding.

How it's done:

The basic circuit for obtaining the required signal is an R-C-C_c T-network with $C >> C_c$. The circuit is

(continued overleaf)

comprised of four main divisions: power supply, dc biasing circuit, 20 volt step function generator, and the current waveform shaping circuit. The left side, stem, and right side of the T represent R, C, and C_c respectively. R is inserted for the purpose of obtaining an integrated time constant RC. A square-wave input voltage to the R side results in the application of a triangular voltage wave to C_c which then delivers a square-wave current output. Different values of R, C, and C_c are selected to provide required pulse characteristics to the circuit under test.

A 115 volt, 60-cycle power source is used: (1) to provide a separate power source (10 vdc) by means of a rectifying circuit for the dc biasing circuit and (2) to provide, through a second rectifying circuit, a 20-volt step function at the contacts of relay 1. If the desired output signal is a biased isolated step function, the only input required is 115 volts, 60 cycles. If a repetitive square-wave output without bias is desired, then it is necessary: (1) to provide another power source which will deliver a 40-volt square-wave at point A, (2) to set the mode switch such that the rectifying circuit (lower left in diagram) is cut out, and (3) to set the biasing resistor switch at infinity to eliminate any input from the entire upper half of the circuit. This means that the square-wave input travels through the R-C-C_c-amplitude switch network only.

For this basic T circuit to develop a triangular wave of sufficient accuracy, it is essential to shield the output terminals and C_c. Also, R must be placed through a hole in a grounded plate. This is accomplished by placing a shield plate half-way between the two switch sections selecting R, with the resistors passing through holes in the plate. The diameter of these holes is not critical, but should be about 3/16 inch when resistors of 1/8-inch body diameter are used. It is also necessary that the right-hand switch section be of the type that grounds the unused contacts.

Notes:

1. If an isolated step function is applied, in place of a repetitive square-wave input, the output current will be a step function followed by exponential decay to zero. This alternate "one shot" mode of operation is necessary when the circuit under test has a response time of a few tenths of a second or more.
2. This instrument has been used to successfully test video preamplifiers used with a scanning electron microscope system and with commercial electron microprobe scanning systems.
3. This innovation may be useful in calibrating nuclear instrumentation and light scattering particle counting equipment.
4. Additional details are contained in *Instrument Society of America (ISA) Transactions,* vol. 4, no. 4, October 1965, p. 374–377.
5. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B67-10318

   Source: W. K. Brookshier,
   Electronics Division
   (ARG-276)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
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